

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1. (previously presented): An ink jet recording apparatus comprising:
 - an ink jet recording head having nozzle orifices from which inkdrops are ejected;
 - an ink storage unit for storing ink to be supplied to the recording head;
 - an ink flow passage communicating the ink storage unit and the recording head;
 - a valve unit for opening/closing the ink flow passage;
 - a capping unit for sealing the nozzle orifices, provided with an air hole communicating with the atmosphere;
 - an air valve for opening/closing the air hole;
 - a suction pump for reducing pressure in an internal space of the capping unit to discharge inkdrops from the nozzles when the capping unit seals the nozzle orifices; and
 - a control unit for controlling the valve unit, the capping unit and the suction pump in such order that:
 - the suction pump decompresses the internal space of the capping unit under a condition that the valve unit closes the ink flow passage and the capping unit seals the nozzle orifice; and
 - the valve unit opens the ink flow passage after a predetermined time period elapses

wherein the air valve always closes the air hole while the suction pump decompresses the internal space of the capping unit.

2. and 3. (cancelled).

4. (original): The ink jet recording apparatus as set forth in claim 1, wherein the predetermined time period is defined as either a time period required for obtaining a satisfactory deaeration degree of ink between the valve unit and the nozzle orifices, or a time period required for accumulating air bubbles therein.

5. (previously presented): An ink jet recording apparatus comprising:
an ink jet recording head having nozzle orifices from which inkdrops are ejected;
an ink storage unit for storing ink to be supplied to the recording head;
an ink flow passage communicating the ink storage unit and the recording head;
a valve unit for opening/closing the ink flow passage;
a capping unit for sealing the nozzle orifices;
a suction pump for decompressing an internal space of the capping unit to discharge inkdrops from the nozzles when the capping unit seals the nozzle orifices; and
a control unit for controlling the valve unit, the capping unit and the suction pump in such order that:

the suction pump decompresses the internal space of the capping unit under a condition that the valve unit closes the ink flow passage and the capping unit seals the nozzle orifice;

the valve unit opens the ink flow passage after a first predetermined time period elapses since the starting of the decompressing by the suction pump; and

the suction pump continues decompressing the internal space of the capping unit for a second predetermined time period after the opening of the ink flow passage.

6. through 32. (cancelled).

33. (previously presented): The ink jet recording apparatus as set forth in any one of claims 1 and 5, wherein the valve unit includes:

a valve control chamber which constitutes a part of the ink flow passage;

a flexible diaphragm which constitute a bottom wall of the valve control chamber;

an actuation body for deforming a center portion of the diaphragm in a direction perpendicular thereto.

34. (original): The ink jet recording apparatus as set forth in claim 33, wherein the valve control chamber has an entrance port formed on a top wall thereof at a portion where is away from the center portion of the diaphragm, and an exit port formed on the top wall at right above the center portion of the diaphragm.

35. (original): The ink jet recording apparatus as set forth in claim 34, wherein the entrance port is arranged below the exit port.

36. (original): The ink jet recording apparatus as set forth in claim 34, wherein the circumferential portion of the exit port is tapered such that a diameter of the port is reduced toward the above.

37. (original): The ink jet recording apparatus as set forth in claim 34, wherein the diaphragm includes an annular convex on the center portion thereof for sealing the exit port when the diaphragm is deformed by the actuation body.

38. (original): The ink jet recording apparatus as set forth in claim 37, wherein an annular groove is formed so as to surround the exit port, against which the annular convex is to be abutted; and wherein an outer peripheral wall of the groove is tapered such that a diameter of thereof is reduced toward the above.

39. (original): The ink jet recording apparatus as set forth in claim 38, wherein a distance between the annular convex and the annular groove is 1.0 - 1.3 mm when the ink flow passage is opened.

40. (original): The ink jet recording apparatus as set forth in claim 34, wherein a cross sectional area of the ink flow passage between the exit port and the recording head becomes larger as further from the exit port.

41. (original): The ink jet recording apparatus as set forth in claim 33, wherein the actuation body is a rod member arranged below the diaphragm.

42. through 65. (cancelled).

66. (previously presented): A cleaning control method for an ink jet recording apparatus which comprises:

- an ink jet recording head having nozzle orifices from which inkdrops are ejected;
- an ink storage unit for storing ink to be supplied to the recording head;
- an ink flow passage communicating the ink storage unit and the recording head;
- a valve unit for opening/closing the ink flow passage;
- a capping unit for sealing the nozzle orifices, provided with an air hole communicating with atmosphere;
- an air valve for opening/closing the air hole;
- a suction pump for reducing pressure in an internal space of the capping unit to discharge inkdrops from the nozzles when the capping unit seals the nozzle orifices, the method comprising the steps of:

closing the air hole using the air valve;
sealing the nozzle orifices by the capping unit;
closing the ink flow passage by the valve unit;
driving the suction pump to decompress the internal space of the capping unit;
holding the decompressed state for a predetermined time period; and
opening the ink flow passage by the valve unit,
wherein the air valve always closes the air hole while the suction pump decompresses the internal space of the capping unit.

67. (original): The cleaning control method as set forth in claim 66, wherein the sealing step and the closing step are executed synchronously or exchangeably.

68. (original): The cleaning control method as set forth in claim 66, wherein the predetermined time period is defined as either a time period required for obtaining a satisfactory deaeration degree of ink between the valve unit and the nozzle orifices, or a time period required for accumulating air bubbles therein.

69. (previously presented): A cleaning control method for an ink jet recording apparatus which comprises:

an ink jet recording head having nozzle orifices from which ink drops are ejected;
an ink storage unit for storing ink to be supplied to the recording head;

an ink flow passage communicating the ink storage unit and the recording head;
a valve unit for opening/closing the ink flow passage;
a capping unit for sealing the nozzle orifices;
a suction pump for reducing pressure in an internal space of the capping unit to discharge inkdrops from the nozzles when the capping unit seals the nozzle orifices,
the method comprising the steps of:
sealing the nozzle orifices by the capping unit;
closing the ink flow passage by the valve unit;
driving the suction pump to decompress the internal space of the capping unit;
holding the decompressed state for a first predetermined time period;
opening the ink flow passage by the valve unit after the first predetermined period has elapsed; and
stopping the driving of the suction pump after a second predetermined time period has elapsed since the opening of the ink flow passage.

70. (original): The cleaning control method as set forth in claim 69, wherein the sealing step and the closing step are executed synchronously or exchangeably.

71. (cancelled).

72. (original): The cleaning control method as set forth in claim 69, further comprises the step of driving the suction pump between the sealing step and the closing step.

73. (previously presented): The cleaning control method as set forth in claim 69, further comprises the step of driving the suction pump again after the stopping step has executed.

74. (original): The cleaning control method as set forth in claim 73, further comprises the steps of:

releasing the capping unit from the nozzle orifices after the suction pump has driven again; and

driving the suction pump again to discharge ink from the nozzle orifices in a capping released state.

75. through 79. (cancelled).

80. (previously presented): An ink jet recording apparatus comprising:
an ink jet recording head having nozzle orifices from which inkdrops are ejected;
an ink storage unit for storing ink to be supplied to the recording head;
an ink flow passage communicating the ink storage unit and the recording head; and
a valve unit for opening/closing the ink flow passage, the valve unit including:

a valve control chamber which constitutes a part of the ink flow passage, the valve control chamber including an entrance port and an exit port;

a flexible diaphragm which constitutes a part of the valve control chamber; and

an actuator having a single rod-shaped body fixed with the diaphragm, the actuator being adapted to be actuated in an axial direction of the rod-shaped body to deform the diaphragm such that only the exit port is closed by the diaphragm.

81. (previously presented): An ink jet recording apparatus comprising:

an ink jet recording head having nozzle orifices from which ink drops are ejected;

an ink storage unit for storing ink to be supplied to the recording head;

an ink flow passage communicating the ink storage unit and the recording head; and

a valve unit for opening/closing the ink flow passage, the valve unit including:

a valve control chamber which constitutes a part of the ink flow passage, the valve control chamber including an entrance port and an exit port;

a flexible diaphragm which constitute a bottom wall of the valve control chamber; and

an actuation body for deforming a center portion of the diaphragm so as to close only the exit port,

wherein the entrance port is on a top wall of the valve control chamber at a portion away from the center portion of the diaphragm, and the exit port is on the top wall at right above the center portion of the diaphragm.

82. (previously presented) The ink jet recording apparatus as set forth in claim 81, wherein the entrance port is arranged below the exit port.

83. (previously presented): The ink jet recording apparatus as set forth in claim 81, wherein the circumferential portion of the exit port is tapered such that a diameter of the port is reduced toward the above.

84. (previously presented): The ink jet recording apparatus as set forth in claim 81, wherein the diaphragm includes an annular convex on the center portion thereof for sealing the exit port when the diaphragm is deformed by the actuation body.

85. (previously presented): The ink jet recording apparatus as set forth in claim 84, wherein: an annular groove is formed so as to surround the exit port, against which the annular convex is to be abutted; and wherein an outer peripheral wall of the groove is tapered such that a diameter of thereof is reduced toward the above.

86. (previously presented): The ink jet recording apparatus as set forth in claim 85, wherein a distance between the annular convex and the annular groove is 1.0-1.3 mm when the ink flow passage is opened.

87. (previously presented): The ink jet recording apparatus as set forth in claim 81, wherein a cross sectional area of the ink flow passage between the exit port and the recording head becomes larger as further from the exit port.

88. (canceled).

89. (previously presented): The ink jet recording apparatus as set forth in claim 80, wherein the actuation body closes the exit port when a negative pressure is applied to the valve control chamber.

90. (cancelled)

91. (cancelled)

92. (new): The ink jet recording apparatus as set forth in claim 1, wherein the control unit controls the valve unit such that the ink flow passage is opened after a predetermined time period has elapsed since the suction pump was stopped driving.

93. (new): The ink jet recording apparatus as set forth in claim 1, further comprises a filter member disposed in the ink flow passage.

94. (new): The ink jet recording apparatus as set forth in claim 5, further comprises a filter member disposed in the ink flow passage.

95. (new): The ink jet recording apparatus as set forth in claim 1 or claim 5, wherein the ink storage unit is an ink cartridge mounted on a carriage for moving the recording head;

wherein the valve unit includes a valve body made of an elastic material through which the ink flow passage; and

wherein the ink flow passage is closed by deforming the valve body with an external force.

96. (new): The ink jet recording apparatus as set forth in claim 95, wherein the valve unit includes a lever member rotatable around a fulcrum portion thereof when the external force is applied to a first end portion thereof to deform the valve body with a second end portion thereof.

97. (new): The ink jet recording apparatus as set forth in claim 96, wherein the lever member includes a pin lever slidably provided at the first end portion thereof to adjust a deforming degree of the valve body, and an elastic member provided between the first end portion and the pin lever.

98. (new): The ink jet recording apparatus as set forth in claim 95, further comprises a pad member against which the lever member is to be abutted so as to deform the valve member when the carriage is moved to a predetermined position.

99. (new): The ink jet recording apparatus as set forth in claim 95, wherein ink storage unit includes a plurality of ink storage tanks provided for respective colors of ink; and wherein the ink supply passage and the valve unit is provided for the respective ink storage tanks.

100. (new): An ink suction method for the ink jet recording apparatus as set forth in claim 95, comprising the steps of:

closing the ink flow passage by the valve unit;
sealing the nozzle orifices by the capping unit;
driving the suction pump to decompress the internal space of the capping unit; and
opening the ink flow passage by the valve unit to discharge ink from the nozzle orifices.

101. (new): The ink suction method as set forth in claim 100, wherein the suction pump decompress the internal space of the capping unit to accumulate air bubbles in the ink between the valve unit and the nozzle orifices.

102. (new): The ink suction method as set forth in claim 100, wherein the steps are executed one time to discharge ink from the nozzle orifices.

103. (new): The ink suction method as set forth in claim 100, wherein the steps are repeated predetermined times to discharge ink from the nozzle orifices.

104. (new): The ink suction method as set forth in claim 103, wherein the next cycle of the steps is executed after the pressure of the internal space has reached for the atmospheric pressure.

105. (new): The ink suction method as set forth in claim 103, wherein the next cycle of the steps is executed before the pressure of the internal space reaches for the atmospheric pressure.

106. (new): A cleaning method for the ink jet recording apparatus as set forth in claim 98, comprising the steps of:

moving the carriage to the predetermined position to drive the valve unit such that the ink flow passage is closed to prevent the discharged ink and air bubbles from flowing back to the nozzle orifices; and

cleaning the nozzle orifices.

107. (new): The ink jet recording apparatus as set forth in claim 95, wherein the ink flow passage in the valve body has a cross sectional shape which is asymmetric with respect to a first line extending perpendicular to a direction of which the external force is applied.

108. (new): The ink jet recording apparatus as set forth in claim 107, wherein the cross sectional shape of the ink flow passage has an apex arranged on the first line extending on a substantial center of the cross sectional shape.

109. (new): The ink jet recording apparatus as set forth in claim 107, wherein the cross sectional shape of the ink flow passage has a rounded corner on a second line extending parallel with the external force direction on a substantial center of the cross sectional shape.

110. (new): The ink jet recording apparatus as set forth in claim 107, wherein the cross sectional shape of the ink flow passage has a side extending parallel with the first line and an apex arranged so as to oppose to the side.

111. (new): The ink jet recording apparatus as set forth in claim 107, wherein a diameter of the valve body is reduced at a portion where the external force is applied.

112. (new): The ink jet recording apparatus as set forth in claim 1 or claim 5, wherein the valve unit includes:

a flexible diaphragm which constitutes a part of a side wall of the ink flow passage; and
an actuation body for deforming the diaphragm in a direction perpendicular to the ink flow passage for opening/closing the ink flow passage.

113. (new): The ink jet recording apparatus as set forth in claim 112, wherein a convex is formed on one face of the diaphragm and the actuation body deforms the diaphragm such that the convex closes the ink flow passage.

114. (new): The ink jet recording apparatus as set forth in claim 113, wherein the actuation body is a rod member to press a portion on the other face of the diaphragm where is opposed to the convex.

115. (new): The ink jet recording apparatus as set forth in claim 1 or claim 5, wherein the valve unit includes:

a flexible diaphragm having a through hole which constitutes a part of the ink flow passage;

an actuation body for deforming the diaphragm in a direction of which the through hole extends while closing one opening of the through hole; and

a wall member for closing the other opening of the through hole when the diaphragm is deformed by the actuation body to close the ink flow passage.

116. (new): The ink jet recording apparatus as set forth in claim 115, wherein the through hole is formed on a substantial center portion of the diaphragm.

117. (new): The ink jet recording apparatus as set forth in claim 115, wherein the wall member is arranged an upstream side of the ink flow passage with respect to the diaphragm to constitute a check valve.

118. (new): The ink jet recording apparatus as set forth in claim 115, wherein the actuation body includes a spring member for normally urging the diaphragm toward the wall member; and wherein a predetermined or more pressure difference between an upstream side and a downstream side of the ink flow passage with respect to the diaphragm moves the actuation body to open the ink flow passage.

119. (new): The ink jet recording apparatus as set forth in claim 1 or claim 5, wherein the ink storage unit includes an air hole communicating with atmosphere, and an air valve for opening/closing the air hole; and wherein when pressure in the ink storage unit reaches for a predetermined value under a condition that both of the air hole and the ink flow passage is closed, the air hole is opened prior to the ink flow passage.

120. (new): The ink jet recording apparatus as set forth in claim 119, wherein the ink flow passage is still closed even if the air hole is opened.

121. (new): The ink jet recording apparatus as set forth in claim 119, wherein the ink storage unit is an ink cartridge.

122. (new): The ink jet recording apparatus as set forth in claim 119, wherein the ink storage unit is a subtank to which a main tank replenishes ink.

123. (new): The ink jet recording apparatus as set forth in claim 119, wherein the air valve is a check valve.

124. (new): The ink jet recording apparatus as set forth in claim 1 or claim 5, wherein the ink storage unit includes an air hole communicating with atmosphere, and an air valve for opening/closing the air hole; wherein a force for closing the air hole is weaker than a force for closing the ink flow passage to discharge internal air of the ink storage unit when pressure inside the ink storage unit is varied due to temperature rising.

125. (new): The ink jet recording apparatus as set forth in claim 124, wherein external air is introduced from the air hole when pressure inside the ink storage unit is varied due to temperature dropping.

126. (new): The ink jet recording apparatus as set forth in claim 124, wherein the ink storage unit is an ink cartridge.

127. (new): The ink jet recording apparatus as set forth in claim 124, wherein the ink storage unit is a subtank to which a main tank replenishes ink.

128. (new): The ink jet recording apparatus as set forth in claim 124, wherein the air valve is a check valve.

129. (new): The ink jet recording apparatus as set forth in claim 1 or claim 5, wherein the ink storage unit includes

- a main tank;

- a subtank communicated with the main tank via an ink replenishment passage;

- a main tank connection unit detachably provided with an ink replenishment passage;

- a decompressor pump for decompressing inside of the subtank to replenish ink from the main tank;

- a pump connection unit detachably provided with a suction passage connecting the subtank and the decompressor pump;

- a first valve provided between the pump connection unit and the subtank for opening/closing the suction passage;

an air hole provided with the subtank which is opened to communicate with atmosphere when the ink jet recording apparatus executes printing; and

an air valve for opening/closing the air hole; and

wherein when pressure in the subtank reaches for a predetermined value, the suction passage is opened prior to the ink flow passage.

130. (new): The ink jet recording apparatus as set forth in claim 129, wherein the ink flow passage is still closed even if the suction passage is opened.

131. (new): The ink jet recording apparatus as set forth in claim 129, wherein the air hole is opened prior to the ink flow passage when the pressure in the subtank exceeds the predetermined value; and wherein the suction passage is opened prior to the ink flow passage when the pressure in the subtank lowers the predetermined value.

132. (new): The ink jet recording apparatus as set forth in claim 131, wherein the ink flow passage is still closed even if the suction passage or the air hole is opened.

133. (new): The ink jet recording apparatus as set forth in claim 129, wherein the ink storage unit includes a second valve detachably provided on the ink replenishment passage at least between the main tank connection unit and the subtank for opening/closing the ink replenishment passage.

134. (new): The ink jet recording apparatus as set forth in claim 133, wherein the second valve is opened according to a pressure difference between the inside and the outside of the subtank when the internal pressure of the subtank becomes a predetermined value or less.

135. (new): The ink jet recording apparatus as set forth in claim 129, wherein the air valve is opened according to a pressure difference between the inside and the outside of the subtank when the internal pressure of the subtank becomes a predetermined value or more.

136. (new): The ink jet recording apparatus as set forth in claim 129, wherein the first valve is opened according to a pressure difference between the inside and the outside of the subtank when the internal pressure of the subtank becomes a predetermined value or less.

137. (new): The ink jet recording apparatus as set forth in claim 1 or claim 5, wherein the ink storage unit includes:

- a main tank;
- a subtank communicated with the main tank via an ink replenishment passage;
- a main tank connection unit detachably provided with an ink replenishment passage;
- a decompressor pump for decompressing inside of the subtank to replenish ink from the main tank;

a pump connection unit detachably provided with a suction passage connecting the subtank and the decompressor pump;

a first valve provided between the pump connection unit and the subtank for opening/closing the suction passage;

an air hole provided with the subtank which is opened to communicate with atmosphere when the ink jet recording apparatus executes printing; and

an air valve for opening/closing the air hole, and

wherein the air hole is opened prior to the ink flow passage when pressure in the subtank exceeds a predetermined value, and the suction passage is opened when the pressure in the subtank lowers the predetermined value.

138. (new): The ink jet recording apparatus as set forth in claim 137, wherein the ink flow passage is still closed even if the suction passage or the air hole is opened.

139. (new): The ink jet recording apparatus as set forth in claim 137, wherein the ink storage unit includes a second valve detachably provided on the ink replenishment passage at least between the main tank connection unit and the subtank for opening/closing the ink replenishment passage.

140. (new): The ink jet recording apparatus as set forth in claim 137, wherein the second valve is opened according to a pressure difference between the inside and the outside of the subtank when the internal pressure of the subtank becomes a predetermined value or less.

141. (new): The ink jet recording apparatus as set forth in claim 137, wherein the air valve is opened according to a pressure difference between the inside and the outside of the subtank when the internal pressure of the subtank becomes a predetermined value or more.

142. (new): The ink jet recording apparatus as set forth in claim 137, wherein the first valve is opened according to a pressure difference between the inside and the outside of the subtank when the internal pressure of the subtank becomes a predetermined value or less.